

Claims

1. A graphite heater for producing a single crystal used when producing a single crystal by the Czochralski method which comprises at least a terminal part to which electric current is supplied and a cylindrical heat generating part by resistance heating and are provided so as to surround a crucible for containing a raw material melt wherein the heat generating part has heat generating slit parts formed by being provided with upper slits extending downward from the upper end and lower slits extending upwards from the lower end by turns, and a length of at least one slit of the upper slits differs from others and/or a length of at least one slit of the lower slits differs from others so that a heat generating distribution of the heat generating part may be changed.

2. The graphite heater for producing a single crystal according to Claim 1 wherein the upper slit and/or the lower slit having a different length from other slits is periodically formed in a circumferential direction, resulting in that the heat generating distribution of the heat generating part is such that the high temperature part and the low temperature part are distributed periodically in a circumferential direction.

3. The graphite heater for producing a single crystal according to Claim 2 wherein the cycle of the heat generating distribution is such that one cycle is 180°.

4. The graphite heater for producing a single crystal according to Claim 2 or 3 wherein the cycle of the heat generating distribution is such that the cycle based on the upper slit and the cycle based on the lower slit are shifted by 45° or more and 135° or less in a circumferential direction.

5. The graphite heater for producing a single crystal according to any one of Claims 1 to 4 which has two or more kinds of the upper slit having a length different from other slits and/or two or more kinds of the lower slit having a length different from other slits.

6. The graphite heater for producing a single crystal according to any one of Claims 1 to 5 wherein the upper slit and/or the lower slit having a length different from other slits has a length shorter than 50 % of a length from the upper end to the lower end of the cylindrical heat generating part.

7. An apparatus for producing a single crystal at least equipped with the graphite heater for producing a single crystal according to any one of Claims 1 to 6.

8. A method for producing a single crystal according to the Czochralski method using the apparatus for producing a single crystal according to Claim 7.

9. A graphite heater for producing a single crystal used when producing a single crystal by the Czochralski method which comprises at least a terminal part to which electric current is supplied and a cylindrical heat generating part by resistance heating and are provided so as to surround a crucible for containing a raw material melt wherein a heat generating distribution of the heat generating part is such that a high temperature part and a low temperature part are periodically distributed in a circumferential direction, and the cycle of the heat generating distribution of the heat generating part is shifted between the upper side and the lower side of a central line dividing the heat generating part in a height direction to the upper side and the lower side.

10. The graphite heater for producing a single crystal according to Claim 9 wherein the periodic heat generating distribution in a circumferential direction of the heat generating part is made by changing any one or more of a wall thickness of a heat generating slit part, a width of a heat generating slit part, a length of a slit, and a material of a heat generating slit part.

11. The graphite heater for producing a single crystal according to Claim 9 or 10 wherein the cycle of the heat generating distribution is such that one cycle is 180° .

12. The graphite heater for producing a single crystal according to any one of Claims 9 to 11 wherein a shift of the cycle of the heat generating distribution between the upper side and the lower side of the central line is 45° or more and 135° or less.

13. An apparatus for producing a single crystal at least equipped with the graphite heater for producing a single crystal according to any one of Claims 9 to 12.

14. A method for producing a single crystal according to the Czochralski method using the

apparatus for producing a single crystal according to Claim 13.

15. The graphite heater for producing a single crystal according to Claim 1 wherein a length of the upper slit consists of two kinds, namely longer and shorter, a length of the lower slit consists of two kinds, namely longer and shorter, and the number of the shorter lower slit is more than the number of the shorter upper slit to change a heat generating distribution in the heat generating part.

16. The graphite heater for producing a single crystal according to Claim 15 wherein the number of the shorter lower slit is twice or more and 5 times or less of the number of the shorter upper slit.

17. The graphite heater for producing a single crystal according to Claim 15 or 16 wherein the two kinds of the upper slit and the lower slit are formed periodically in a circumferential direction, resulting in that the heat generating distribution of the heat generating part is such that a high temperature part and a low temperature part are periodically distributed in a circumferential direction.

18. The graphite heater for producing a single crystal according to Claim 17 wherein the cycle of the heat generating distribution is such that one cycle is 180°.

19. The graphite heater for producing a single crystal according to Claim 17 or 18 wherein the cycle of the heat generating distribution is such that the cycle based on the upper slit and the cycle based on the lower slit are shifted by 45° or more and 135 ° or less in a circumferential direction.

20. The graphite heater for producing a single crystal according to any one of Claims 15 to 19 wherein the shorter upper slit and lower slit has a length shorter than 50 % of a length from the upper end to the lower end of the heat generating part.

21. The graphite heater for producing a single crystal according to any one of Claims 15 to 20 wherein the longer upper slit and lower slit has a length of 70 % or longer of a length from the upper end to the lower end of the heat generating part.

22. An apparatus for producing a single crystal at least equipped with the graphite heater for producing a single crystal according to any one of

Claims 15 to 21.

23. A method for producing a single crystal according to the Czochralski method using the apparatus for producing a single crystal according to Claim 22.

24. The graphite heater for producing a single crystal according to Claim 1 wherein a length of the upper slit consists of two kinds, namely longer and shorter, and a width of a lower end of the longer upper slit is wider than a width of an upper end thereof, and/or a width of a lower end of the lower slit is wider than a width of an upper end thereof to change the heat generating distribution of the heat generating part.

25. The graphite heater for producing a single crystal according to Claim 24 wherein the lower end of the longer upper slit has a width of 1.5 times or more and 2.5 times or less of a width of the upper end thereof, and the lower end of the lower slit has a width of 1.5 times or more and 2.5 times or less of a width of the upper end thereof.

26. The graphite heater for producing a single crystal according to Claim 24 or 25 wherein the shorter upper slit has a length shorter than 50 % of a length

from the upper end to the lower end of the heat generating part.

27. The graphite heater for producing a single crystal according to any one of Claims 24 to 26 wherein the longer upper slit has a length of 70 % or longer of a length from the upper end to the lower end of the heat generating part.

28. The graphite heater for producing a single crystal according to any one of Claims 24 to 27 wherein the two kinds of the upper slit are formed periodically in a circumferential direction, resulting in that the heat generating distribution of the heat generating part is such that a high temperature part and a low temperature part are periodically distributed in a circumferential direction.

29. The graphite heater for producing a single crystal according to Claim 28 wherein the cycle of the heat generating distribution is such that one cycle is 180°.

30. An apparatus for producing a single crystal at least equipped with the graphite heater for producing a single crystal according to any one of Claims 24 to 29.

31. A method for producing a single crystal according to the Czochralski method using the apparatus for producing a single crystal according to Claim 30.

32. The graphite heater for producing a single crystal according to Claim 1 wherein each of a length of the upper slit and a length of the lower slit consists of two kinds, namely longer and shorter, and the number of the shorter upper slit is more than the number of the shorter lower slit, to change the heat generating distribution of the heat generating part.

33. The graphite heater for producing a single crystal according to Claim 32 wherein the number of the shorter upper slit is 1.5 times or more and 5 times or less of the number of the shorter lower slit.

34. The graphite heater for producing a single crystal according to Claim 32 or 33 wherein the two kinds of the upper slit and the lower slit are formed periodically in a circumferential direction, resulting in that the heat generating distribution of the heat generating part is such that a high temperature part and a low temperature part are periodically distributed in a circumferential

direction.

35. The graphite heater for producing a single crystal according to Claim 34 wherein the cycle of the heat generating distribution is such that one cycle is 180°.

36. The graphite heater for producing a single crystal according to Claim 34 or 35 wherein the cycle of the heat generating distribution is such that the cycle based on the upper slit and the cycle based on the lower slit are shifted by 45° or more and 135° or less in a circumferential direction.

37. The graphite heater for producing a single crystal according to any one of Claim 32 to 36 wherein the shorter upper slit and lower slit has a length shorter than 50 % of a length from the upper end to the lower end of the heat generating part.

38. The graphite heater for producing a single crystal according to any one of Claim 32 to 37 wherein the longer upper slit and lower slit has a length of 70 % or longer of a length from the upper end to the lower end of the heat generating part.

39. An apparatus for producing a single crystal

at least equipped with the graphite heater for producing a single crystal according to any one of Claims 32 to 38.

40. A method for producing a single crystal according to the Czochralski method using the apparatus for producing a single crystal according to Claim 39.